

RTS

Sorensen
POWER SUPPLIES

**instruction
manual
for STM SERIES
MODULAR DC
POWER SUPPLIES**

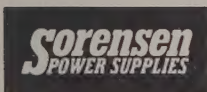
INCLUDES THE FOLLOWING STM MODELS:

MODULE III		MODULE IIIA	
3.5-24	18-10	3.5-36	18-15
5-24	24-8.5	5-36	24-13
9-12	28-7	9-20	28-11
12-12	36-4	12-20	36-6
15-10	48-4	15-15	48-6

S O R E N S E N C O M P A N Y

A UNIT OF RAYTHEON COMPANY

676 ISLAND POND ROAD MANCHESTER , NEW HAMPSHIRE 03103



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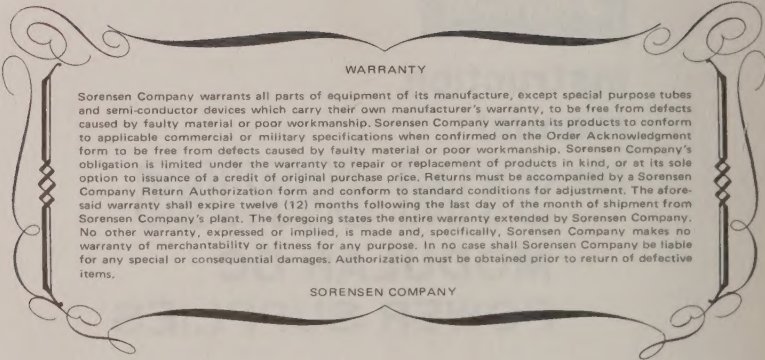
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1 INTRODUCTION

1.1 PURPOSE

This manual contains operation and maintenance instructions for the STM series of high efficiency modular dc power supplies, manufactured by the Sorensen Company, Manchester, New Hampshire. The STM models included in this manual are similar in electrical design and physical appearance. They are grouped into two module sizes; III and IIIA, differing only in size and in power output ratings. (Refer to table 1-1, Unit Specifications.)

1.2 GENERAL DESCRIPTION

The STM series provides a variety of highly regulated dc outputs and is designed for operation on 115 Vac or 150 Vdc. The line also offers exceptionally high efficiency and fast recovery times as well as characteristically low output impedances.

The supplies are designed for mounting in any of three attitudes; end, bottom or side. Four tapped mounting holes are provided on each side. Section 2 provides necessary installation data.

1.3 FUNCTIONAL DESCRIPTION

Operational features of the STM series power supplies include remote sensing (regulating), remote programming, overload and short-circuit protection by automatic current-limiting, and over-voltage protection through an integral electronic crowbar shorting circuit.

1.3.1 Remote Sensing

For applications where variation in the load-lead voltage drop may adversely affect load regulation, remote sensing may be used to establish the regulating point at the load rather than at the output terminals.

1.3.2 Remote Programming

The STM series power supply outputs may be altered from a remote location by either the resistance or the voltage programming methods.

For resistance programming, a calculated value of resistance at the ratio of 1000 ohms/volt is inserted in the programming network. For voltage programming, a value of voltage at the ratio of 1:1 is inserted.

1.3.3 Series Operation

For applications requiring output voltages higher than a single unit can provide, STM units may be connected in series to a maximum total of 200 Vdc. Regulation in series operation is the sum of the regulations of all units.

1.3.4 Parallel Operation

STM units are not designed for parallel operation.

1.3.5 Over-Current Protection

In the event of an excessive current condition, such as a short-circuit, a current-limit circuit acts to reduce the unit output voltage. This circuit is factory-set to at least 115% of the unit rated output current at 40°C (+104°F).

1.3.6 Over-Voltage Protection (OVP)

In the event of an over-voltage condition on the output, such as a failure in the power supply or an externally induced condition, an over-voltage electronic crowbar is actuated by an integral OVP sensing circuit. The crowbar acts to quickly reduce the output voltage to zero and to disable the input dc circuit.

1.4 ACCESSORIES

Several universal rack-mount adaptors are available for the STM series. For specific information on these adaptors, contact your service representative, or the factory.

Table 1-1A Common Specifications

Input Rating:		AC; 105-132 volts, 50-440 Hz, single phase	
DC; 150 Vdc, $\pm 15\%$			
Maximum Input Current:			
Nominal Input Voltage		Module III Amperes	Module IIIA Amperes
115 Vac		4.0	5.5
150 Vdc		1.9	3.2
Recommended Fuse, @ Nominal Input Voltage:			
		6	8
Output Ratings:			
Efficiency		To 75%	
Voltage Regulation		0.05% (combined line and load)	
Ripple, RMS		3 mV maximum (5 mV on 3.5/5-volt models)	
Ripple, P-P		50 mV maximum (typically 30 mV)	
Temp. Coefficient		0.01% per $^{\circ}\text{C}$	
Turn-ON/OFF overshoot		None (output voltage)	
Transient Response		1.0 millisecond for half-load change/return to 1% band	
Remote Programming		1000 ohms per volt (resistance)/ 1V:1V (signal)	
Output Impedance:		Typically less than	
		0.005 ohm @ 10 kHz	
		0.01 ohm @ 50 kHz	
		0.015 ohm @ 100 kHz	
		0.02 ohm @ 500 kHz	

Table 1-1A Common Specifications (cont'd)

Current Limit:	Automatic, internally adjustable from zero to 125% of rated full-load current. Factory set to approximately 115% of rated (40°C) current. (See individual unit specifications.)
Over-voltage (OVP) Limit:	Automatic, adjustable crowbar action, self-contained. Factory-set at 1V or 10% of nominal output voltage. (See unit specifications) Reset requires cycling input power. (Allow 30 seconds for discharge of input capacitors.) OVP action is delayed (typically) by approximately 100 microseconds to avoid nuisance tripping. Resolution of OVP adjust 0.1% of output voltage rating (typical). OVP stability 2% of voltage trip setting for all conditions (typical).
EMI (RFI):	Designed to meet most portions of MIL-STD-461A.
Stability:	After one hour warm-up, 0.05% for 24 hours with all external effects held constant.
Resolution:	0.05% of output voltage maximum. (See individual unit specifications.)
Parallel Operation:	Not recommended.

Table 1-1A Common Specifications (cont'd)

Series Operation: To 200 Vdc maximum.	
Remote Sensing:	The voltage drop per load lead is constrained only by the maximum rated unit output voltage. (For example, 5-volt nominal STM supplies have an E_o maximum of 6.0 volts. Thus, operating at an output of 5 volts allows a total of 1.0 volt total lead drop, or 0.5 volt per load lead.)
Ambient Rating:	0 to 71°C/32 to 160°F (See current ratings in unit specifications.)
Cooling:	Natural convection.
Dimensions (inches):	<u>Module III</u>
	<u>Module IIIA</u>
	Width 5-1/8 5-1/8
	Height 3-5/16 3-5/16
Weight (lbs)	Depth 9-1/2 14
	6-1/2 9
Volume (cu. in.)	160 238
Input-Output Connections: All connections are made to a 7-terminal barrier strip using #5-40 screws.	

Table 1-18 Unit Specifications Module III

Model No.	3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4
Output Ratings: (dc)										
Nominal Voltage (V)	3.5	5.0	9.0	12.0	15.0	18.0	24.0	28.0	36.0	48.0
Voltage Range (V)	3.0-4.5	4.5-6.0	6-10	9.5-13.5	13-17	16-20	19-25	24-30	29-43	42-56
Regulation (mV)	1.75	2.5	4.5	6.0	7.5	9.0	12.0	14.0	18.0	24.0
Current (A):										
@ 40°C	24.0	24.0	12.0	12.0	10.0	10.0	8.5	7.0	4.0	4.0
@ 50°C	19.4	19.4	9.7	9.7	8.1	8.1	6.8	5.6	3.2	3.2
@ 60°C	14.9	14.9	7.5	7.5	6.2	6.2	5.3	4.3	2.5	2.5
@ 71°C	9.6	9.6	4.8	4.8	4.0	4.0	3.4	2.8	1.6	1.6
Current Limit (A dc)										
Factory set to:	27.6	27.6	13.8	13.8	11.5	11.5	9.8	8.0	4.6	4.6
Over-voltage Limit (Vdc)										
Factory set to:	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typ.)										
Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.75	8.5	10.0	12.5	15.0	21.5	28.0

Table 1-1C Unit Specifications Module IIIA

Model No.	3-5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6
Output Ratings: (dc) Nominal Voltage (V) Voltage Range (V) Regulation (mV) Current (A); @ 40°C @ 50°C @ 60°C @ 71°C	3.5 3.0-4.5 1.75	5.0 4.5-6.0 2.5	9.0 6-10 4.5	12.0 9.5-13.5 6.0	15.0 13-17 7.5	18.0 16-20 9.0	24.0 19-25 12.0	28.0 24-30 14.0	36.0 29-43 18.0	48.0 42-56 24.0
	36.0 29.1 22.3 14.4	36.0 29.1 22.3 14.4	20.0 16.2 12.4 8.0	20.0 16.2 12.4 8.0	15.0 12.1 9.3 6.0	15.0 12.1 9.3 6.0	13.0 10.5 8.0 5.2	11.0 8.5 6.8 4.4	6.0 4.8 3.7 2.4	6.0 4.8 3.7 2.4
	41.4	41.4	23.0	23.0	17.3	17.3	12.0	12.7	6.9	6.9
	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typical) Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.25	8.5	10.0	12.5	15.0	21.5	28.0

2 INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary check-out procedures should be performed to assure that the unit is in proper working order. If it is determined that the unit has been damaged, the carrier should be notified immediately. Repair problems may be directed to the nearest Sorensen representative, or to the Service Department, Sorensen Company, Manchester, New Hampshire.

2.2 INSPECTION

Check for damage incurred during shipment as follows:

1. Inspect enclosures for dents, chips and other obvious signs of damage.
2. Check condition of external terminal board. Make certain that all terminal screws are in place and that links are fitted over the barrier strips between terminals 1 and 2, and between 3 and 4.
3. Inspect fuse holders for evidence of damage.
4. If internal damage is suspected;
 - a. Remove all flat-head retaining screws from around the perimeters of the case assembly.

NOTE:

For module IIIA units, it is only necessary to remove the top (and one side) of the casing.

- b. Remove the round-head screws from the rear panel and remove the case.
- c. Inspect the components and printed circuit board (PCB) for damage.

5. Check that the power transistors are firmly plugged into their sockets. These are readily removable for servicing.

2.3 INPUT CONNECTIONS

STM units are shipped ready for use with either 115 Vac or 150 Vdc.

NOTE

For either connection, fuse F1 is in series with the input line connected to TB1 pin 7. Maximum circuit protection is provided when the high side of the input line (the black wire in standard ac connections) is connected to this pin.

2.4 ELECTRICAL CHECK

CAUTION

Before applying power to the unit, it is important that input/output isolation be checked. This may be done using a VOM set to the $\times 10$ K scale. Assure maximum resistance from input at TB1-6 and -7 to case (ground), and output at TB2-1 to case.

It is recommended that this measurement be performed each time the unit case is removed and replaced.

To perform an initial electrical check, proceed as follows:

1. Make certain that unit is located in an area where free passage of air is unrestricted. Connect input leads to terminals TB1-6 and -7 (IN). Use terminal 5 (GRD) for input system ground.
2. Connect a dc voltmeter across terminals TP1-1 and -4 (OUTPUT SENSING). Select a voltage range compatible with rated output.

3. Apply nominal rated input power.
4. Rotate output adjust sufficiently to swing the dc voltmeter from minimum rated voltage to nominal output voltage per table 1-1. (Adjustment to 1 volt or 10% higher than nominal output will trip the OVP.)
5. Set output voltage at its nominal value and remove input power.

2.5 MOUNTING

STM units may be mounted in a variety of positions and locations, including rack mounting.

NOTE

Specific data for rack mounts is available at the factory. Fabricate knockout panels as shown in figure 2-2. Figure 2-1 is an overall outline drawing of the STM modules.

1. For cantilever-type mounting from a vertical panel or wall (where free access to vertical airflow is available):

End mounting - Use knockout per figure 2-2. This knockout clears the terminal block and fuses.

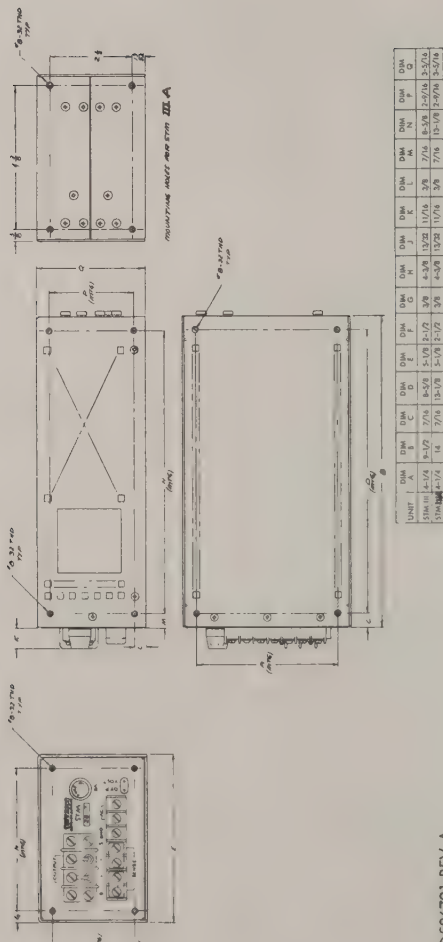
Side or bottom mounting - No knockout is needed. Use the four mounting holes shown in figure 2-2.

2. For flat mounting from a horizontal surface (where free access to vertical air flow is not available):

End mounting - Not recommended.

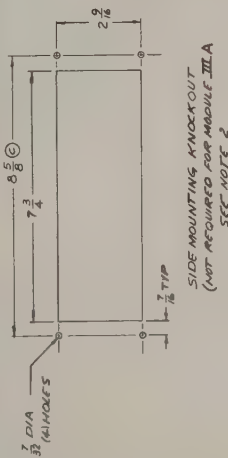
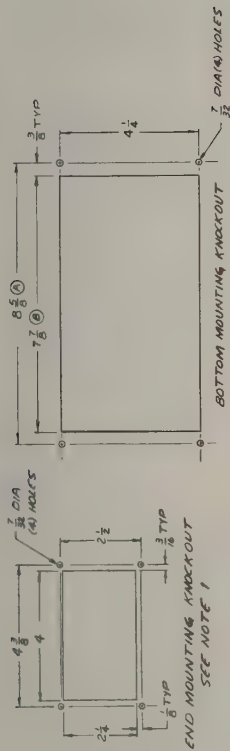
Side mounting - Module III units, use knockout per figure 202. Module IIIA units may be mounted directly with no knockout required.

Bottom mounting - Use knockout per figure 2-2.



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Figure 2-1
Outline Drawing, STM Modules III and IIIA



MODULE IIIA

A	B	C
13 1/8	12 3/8	13 1/8

- NOTES:
1. MOUNTING HOLES ARE PROVIDED AT BOTH ENDS OF MODULE III A, FOR ADDITIONAL SUPPORT WHEN REQUIRED.
 2. FOR MODULE III A, MOUNT DIRECTLY. NO KNOCKOUT REQUIRED.

Figure 2-2
Knockout Dimensions, STM Modules III and IIIA

3. Vertical panel mounting per paragraph 1 preceding is preferred since maximum air flow is assured. Horizontal surface mounting per paragraph 2 preceding, using bottom mounting with proper knockout is the second preference.
4. Mounting screws should be No. 8-32 and just long enough to penetrate 1/4 inch into the STM unit and through the mounting surface with lock/flat washers used.

3 OPERATION

3.1 GENERAL

This section contains instructions on how to adapt the unit to, and operate it in, a number of varied applications. These include remote sensing, remote programming, and series operation.

CAUTION

1. The sensing and power circuits form a closed loop. Opening this loop, either by removing a terminal board link or disconnecting a sensing or programming lead will result in a high unit output and will cause the OVP crow-bar to operate.
2. Continuous operation with an input less than 85 Vac will damage the unit.

3.2 CONTROLS

STM units are equipped with two controls; the output adjust and the OVP adjust potentiometers. The output adjust control R26 is used to vary the output voltage while the OVP adjust control R14 is used to vary the OVP trip point. Both are factory-set to nominal values (see table 1-1).

3.3 PRE-OPERATION CONSIDERATIONS

3.3.1 Current Limit Setting

The current limiting point is factory-set to approximately 115% of rated 40°C current. If the unit is to be operated in other ambients, the rated output current is derated per table 1-1. It is recommended that for ambient temperatures above 40°C, the limit should be reset to approximately 115% of the rated output current.

3.3.2 Current Limit Reset

To reset the current limit proceed as follows:

1. Rotate limit adjust control R38 on A100 printed circuit board (PCB) fully clockwise (CW)
2. Connect a voltmeter across output terminals TB1-1 and -4. Apply nominal input power and adjust output voltage control (R26) for the unit's rated nominal value.
3. Remove input power and connect an ammeter and variable load resistor in series across the output terminals.
4. Reapply input power and adjust load so that the test ammeter indicates current limit determined in paragraph 3.3.1.
5. Rotate R38 on the A100 PCB slowly counterclockwise (CCW) until both output voltage and current begin to drop.
6. Remove input power, disconnect test instruments and load. Replace top cover.

3.3.3 Over-Voltage Trip Point

The OVP trip point is factory set to 1V or 10% (whichever is greater) higher than the rated nominal output voltage (table 1-1). However, if the output voltage will be operated near its maximum rating, it may be desired to raise the trip point. For nuisance-free OVP, the trip point should be maintained at least 1V or 10% (whichever is greater) above the operating voltage. For example, a 5V model operating at 5.5V should use a 6.5V trip setting.

3.3.4 OVP Trip Point Reset

To reset the OVP, proceed as follows:

1. Rotate OVP control (R14) on panel fully CW.

2. Rotate output control (R26) on panel until the output voltage is equal to the desired trip point.
3. Rotate OVP control R14 slowly CCW until the output voltage suddenly drops to zero. This indicates OVP has triggered the crow-bar.
4. Remove the input power. Rotate output control CCW. Allow approximately 30 seconds for unit to discharge.
5. Apply input power. Reset output until desired operating voltage is obtained.

NOTE: The OVP circuit includes a time-delay network such that the over-voltage condition must exist for approximately 100 microseconds before the OVP fires. This delay prevents short-duration OV pulses from triggering the crow-bar.

3.3.5 Reset After OVP Fires

If the OVP fires, proceed to reset the circuit as follows:

1. Remove input power and disconnect load (in case OV condition is externally induced). Allow approximately 30 seconds for unit to discharge.
2. Rotate output adjust R26 fully CCW (minimum voltage).
3. Apply input power and raise output voltage to desired value.

NOTE: If the OVP again trips, internal failure is indicated, or the output is set too close to operating voltage (see 3.3.4 above).

3.4 LOCAL SENSING

The unit is shipped ready for use in the local-sensing mode. In this mode, regulation is at the output terminals, not at the load. If variations in load-line voltage drops are expected to be prohibitive, refer to paragraph 3.5, remote sensing.

To operate the unit, proceed as follows:

1. Connect a voltmeter across output sense terminals TB1-1 (+) and TB1-4 (-).
2. Attach the input leads to terminals TB1-6 and -7. Use terminal 5 (GND) to ground input system.
3. Apply nominal input power.
4. Rotate output adjust until desired output voltage is indicated on voltmeter.
5. Remove input power, disconnect voltmeter and connect load leads to terminals TB2-1 and -2. Do not remove or loosen any of the interconnecting links. Apply nominal input. Unit supplies highly regulated power to load.

CAUTION

Do not touch enclosure while unit is operating under load. Surface temperature is comparatively high. If unit must be handled immediately after operation, wear heat-resistant gloves.

3.5 REMOTE SENSING

If it is desirable to sense (regulate) unit output at the load rather than at output terminals, remove the links between terminals TB1-1 and -2, and TB1-3 and -4. Run a sensing lead from

terminal TB1-1 to the positive side of load; Connect the other lead from terminal TB1-4 to the negative side of load (see figure 3-1). Sensing leads should be fabricated using a shielded, twisted pair of wires. Set unit in operation per paragraph 3.4.

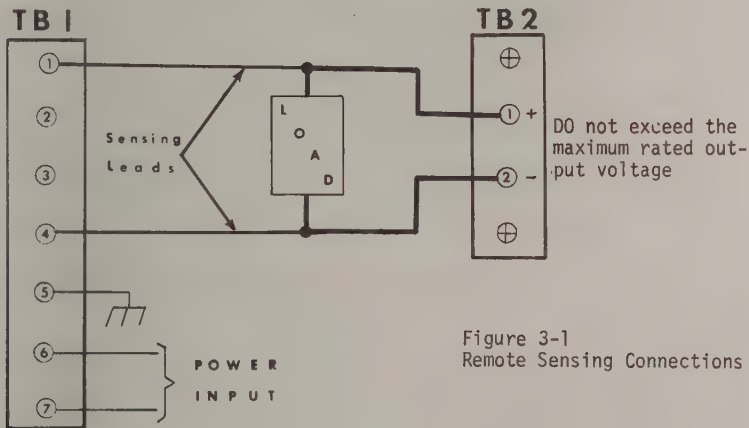


Figure 3-1
Remote Sensing Connections

3.6 REMOTE PROGRAMMING

The unit may be programmed to supply pre-determined output voltages by inserting a calculated resistance into the voltage-sensing circuit. Programming sensitivity is approximately 1000-ohms-per volt; that is 1000 ohms are required for each volt difference between the desired output and the minimum value of the unit's specified range. The program resistor should be a 1/8-watt (or larger) precision film resistor with a 25 PPM/°C coefficient (equal to MIL style RN55E). The programming current is approximately 1 milliampere. However, a 1.0 uF capacitor in parallel with the inserted programming resistor is required to prevent the unit from oscillation.

To adapt the unit for remote programming, proceed as follows:

1. With normal local sensing (paragraph 3.4), set power to ON and adjust output to specified rated minimum output voltage (see table 1-1 for specific model). For example, for a 12V module, set the output to 9.5 volts.
2. At this point, any value within rated output range (table 1-1) can be obtained by inserting 1000 ohms-per-volt difference between the desired voltage and the minimum voltage. For example, to obtain 12.0-volt output in the above example, the difference is 12.0 (-) 9.5 or 2.5 volts. The program resistor should be 2.5×1000 or 2.5K ohms.
3. Parallel the program resistor with a 1.0uF capacitor.
4. Set power to OFF. Remove the link from TB1-3 and TB1-4 and connect programming resistor in its place. Note that either local or remote sense can be used.
5. Apply input power and verify load voltage across terminals TB2-1 and -2 as the desired value (using local sense).

3.7 SERIES OPERATION

Series operation is utilized for the purpose of obtaining a higher output voltage than available from a single model. Two supplies may be connected in series to form a dual polarity (+) & (-) output system such as (+) 12V with a common return. Any amount of bridging load may be tolerated.

3.8 PARALLEL OPERATION

Not recommended for STM units.

4 THEORY OF OPERATION

4.1 BASIC STM PRINCIPLES (Refer to figure 4-1; block diagram)

STM circuitry incorporates 20-kHz switching techniques, contributing to high efficiency and exceptional power density (high power output capability and small physical size).

The basic circuit consists of a 20-kHz push-pull, pulse width modulated inverter operating directly from the rectified ac line. The inverter output is rectified and filtered in a double L-C filter, and the resultant dc output voltage is sensed and compared with a reference voltage. Any difference, or error voltage is amplified and fed back to the inverter to control the pulse width. Thus a closed loop is achieved, resulting in excellent line/load regulation.

4.2 CIRCUIT DESCRIPTION

4.2.1 Input Circuits (Refer to schematic diagram, figures 5-2/5-3)

Input power is full-wave rectified through diode bridge CR1 (or CR1-CR4 as applicable) and filtered by C1 and C2. Approximately 150Vdc (depending on the input line variations) appears across capacitor C2, on which is superimposed a 120Hz component (twice the line frequency). This dc control voltage establishes the operating levels of two separate inverter networks. One is the push-pull inverter T1, Q3 and Q4, and the second, at a lower level, is the bias inverter T1, Q2 and Q3 on the A100 printed circuit board (PCB), properly designated A100T1, A100Q2 and A100Q3 (figure 5-6).

4.2.2 Ramp Generator Circuit (figure 5-6)

The ramp generator, consisting of (A100) Q1, C2, and R2, is designed to operate at a repetition rate of 40kHz, and serves as the master "clock" for the power supply.

Capacitor A100C2 charges at a pre-determined rate until its voltage reaches a level established by A100VR4. At that point, programmable unijunction transistor (PUT) A100Q1 fires, resetting the ramp generator. The ramp output is fed to comparator circuit A100IC5,

and a trigger pulse, developed across A100R3, is fed to the multi-vibrator circuit at IC1E.

4.2.3 Multivibrator and Bias Supply

The multivibrator (MV) circuit provides a square-wave output at 20kHz (just half of the ramp generator trigger pulse repetition rate) which supplies the base drive for bias inverter transistors (A100) Q2 and Q3. (A100) Q2 and Q3 in turn drive the primary of bias supply transformer A100T1.

The dc operating voltage (150V from the input circuit) is applied at P1-6 to MV IC1 at a reduced level of approximately 12V, determined by (A100) VR1, VR2 and associated circuitry. During turn-on the MV will free-run and produce a 15-kHz square wave. Once the bias circuit reaches proper operating level, the ramp generator functions, and the MV is driven at a 20-kHz rate by the trigger pulses at A100IC1E. At that point, bias transformer A100T1 is operating with a 20-kHz square wave on all windings.

The three separate secondaries of A100T1 function as follows:

1. Pins 4-6; develop bias voltages for the ramp generator, comparator, and current limiter A100Q5 and associated circuitry.
2. Pins 7-9; supply base drive current for main switching transistors Q3 and Q4 through Q1 and Q2 on the chassis assembly.
3. Pins 10-12; provide bias for reference and error amplifier circuitry (A100) IC2, IC4 and associated components.

4.2.4 Comparator and OR Gate

The comparator circuit consists primarily of integrated circuit (IC) components (A100) IC5A, B, and C. The comparator compares the relatively constant output of the ramp generator (at the base of IC5C) with the variable output of the OR gate, consisting of diodes (A100) CR8, 9, and 10, at the base of IC5A. The

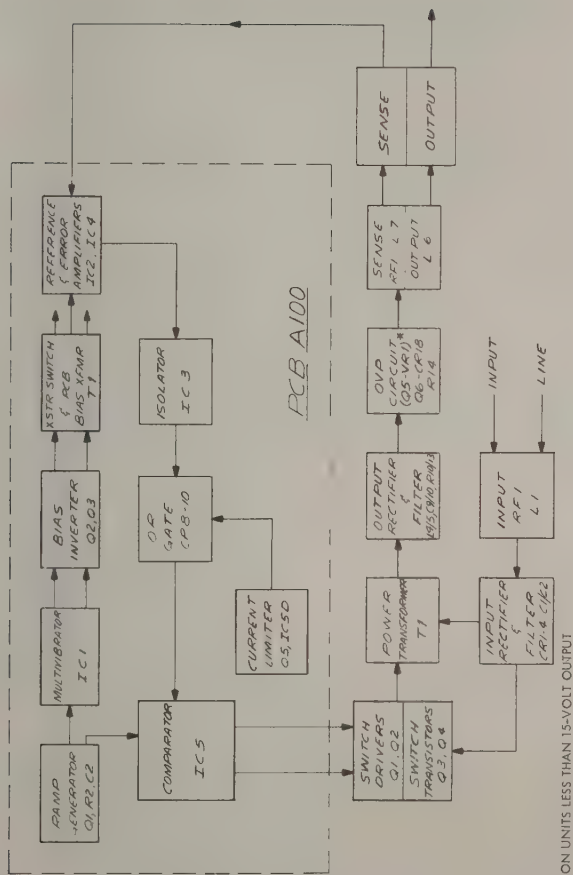


Figure 4-1 STM Simplified Block Diagram

*ON UNITS LESS THAN 15-VOLT OUTPUT

resultant comparator output pulse at IC5B is amplified through (A100) Q6 and Q7 simultaneously, and fed to switch driver transistors Q1 and Q2 on the chassis assembly.

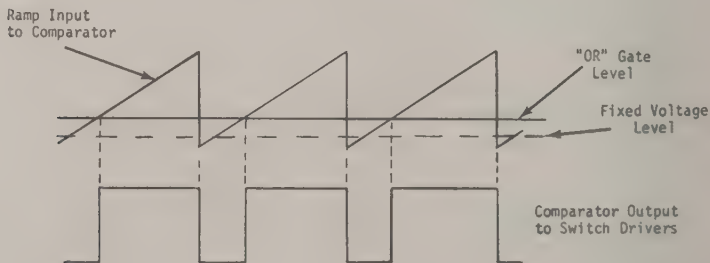
The OR gate takes the larger of three inputs and passes it on to the comparator.

The inputs are as follows:

1. A fixed voltage at (the anode of) A100CR8 developed by (A100) VR4, R29, and R30.
2. The error amplifier output at A100CR9, through isolator A100IC3B.
3. The current-limiting circuit output developed at A100CR10.

In a typical operating situation, any tendency of the supply output to increase is sensed through error amplifier A100IC4. This output controls the OR gate through (A100) IC3 and CR9, increasing the gate output to the comparator and thus narrowing the width of the pulse which controls the ON time of switches Q3/Q4.

This function is illustrated in the following diagram:



The fixed voltage at A100CR8 establishes a maximum pulse width (minimum OR output) allowable, to protect switching transistors Q3 and Q4. Wider pulses might conceivably overlap, damaging transistors Q3 and Q4 by switching both ON at the same time.

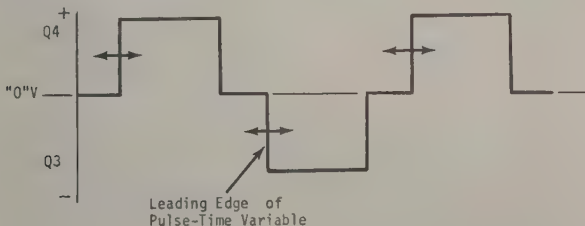
4.2.5 Switching Transistors

As noted previously, switching transistors Q3 and Q4 react to the output of the comparator through their respective drivers Q1 and Q2. This input rectangular wave, with a 40-kHz repetition rate is fed simultaneously to the bases of Q1 and Q2. Only one will be activated however, as the collectors of each are connected to secondary 7, 8, and 9 of bias transformer A100T1. Thus, while one is turned ON (+5 volts), the other will be at cut-off (-5 volts). Since the transformer waveform is 20kHz, synchronized with the comparator, alternate comparator outputs are fed to Q1/Q2.

The comparator thus turns on the appropriate drive transistor, which in turn activates switching transistors Q3 or Q4. Turn-off of Q3 and Q4 is accomplished by diodes CR5 and CR10 in conjunction with bias transformer A100T1. This action results in very rapid turn-off of the switching transistors.

4.2.6 Output Circuits (figures 5-2/5-3)

The switching action of Q3/Q4 results in the following string of pulses at the primary of transformer T1: (Pulsewidth determined by ramp vs. OR gate output).



At the secondary, rectification takes place through CR11 (and CR19/20 where used). The resultant signal at a 40-kHz repetition rate, is then filtered by L4/C9, and L5/C10, and appears as the supply output voltage at TB2-1 (+) and TB2-2 (-). The integration function of the filtering reduces the 40-kHz component of the output to less than 3 millivolts.

4.2.7 Reference and Error Amplifiers (figure 5-6)

Integrated circuits IC2/IC4 on PCB A100 are the primary components of the reference and error amplifiers respectively. The circuits derive operating power from secondary windings 10, 11, and 12 of bias transformer A100T1. The waveform at the secondary is rectified by (A100) CR4/CR5, and filtered by A100C9. Integrated circuit A100IC2 functions as a voltage regulator, and produces a constant 16Vdc from pins 7 (+) to 6 (-). This regulated voltage is used to bias error amplifier A100IC4, and more importantly, A100VR3, which is the primary voltage reference diode for the supply. The anode of VR3 is connected to the unit positive sense terminal (TB1-1) through R22 and L7 (A) on the main chassis.

In a stable condition of supply operation, terminals 3 and 4 of error amplifier A100IC4 will be at zero volts. With the input bias to IC4 at less than 0.1 microampere, the voltage across A100R26 is essentially at zero. Using these basic assumptions, the voltages at P1-1 and P1-2 will be at zero, and thus the current noted at P1-1 is the sum of those through (A100) R24/R25. Potentiometer A100R23 has been adjusted to maintain this current at 1.0 milliampere (the unit programming current). This level remains constant until an error (change) voltage is sensed at the supply output. The programming current thus appears at A100IC4 pin 2, and at negative sense terminal TB1-4 through R23/R25/L7B on the main chassis. A100IC4 pin 3 is connected to positive sense terminal TB1-1 through A100R26, and R22 and L7 (A) on the main chassis.

Any variation in output voltage is instantly sensed at the error amplifier, and processed through isolator A100IC3 to an arm of the OR gate, and through the comparator. Then, as described in paragraph 4.2.4, switching pulses are widened or narrowed as required to counter-react variations in output voltage. Diodes (A100) CR6/CR7 act to protect the error IC circuit from large variations in output voltage.

Thus is formed a negative feedback loop consisting of: error amplifier, isolator, OR gate, comparator, switching transistors, T1 (main chassis) and output rectifiers and filters. Compensation is provided in the negative sensing circuit by C18/R24 together with (A100) C11/R22 to ensure that the loop remains free of oscillations.

4.2.8 Current Limiting Circuit (figure 5-6)

This circuit, consisting of (A100) Q5, IC5D, CR12 and C15 serves to protect the supply in the event of excessive current demands such as a short-circuited output. By design, a fixed relationship exists between the unit output current and the peak current of switching transistors Q3/Q4. Therefore, by limiting Q3/Q4 peak current, the output current is controlled.

The peak voltage across R5 on the main chassis (due to Q3/Q4 switching current) is applied to peak charging circuit (A100) C15/CR15 through P1-12/-5 on the PCB connector. The capacitor charge, then, is proportional to both peak switching and dc output currents. A reference (threshold) voltage is developed by (A100) VR4, R38/R34 and appears across A100R35. When the voltage at A100C15 exceeds a critical value established by this threshold, A100IC5D, and consequently A100Q5, (acting as an error amplifier) conducts. This action causes the A100CR10 arm of the OR gate to take control of the feedback loop (current limit mode), producing whatever voltage is necessary to restrict the supply output current.

A100CR12 acts as a temperature-compensating diode between the base-emitter junction of NPN transistor A100IC5D, adding temperature stability to the circuit.

4.2.9 Over-Voltage Protection (OVP) Circuits (figures 5-2/5-3)

The OVP circuit senses an over-voltage condition at the output terminals, and acts to fire diode CR18, momentarily shorting the output voltage. Either of two circuit designs are used, depending on the level of output voltage. Both are analyzed in the following paragraphs.

4.2.9.1 Supply Outputs to 12 Volts

For these lower voltage supplies, regulator VR1 establishes the over-voltage reference level. Its bias is set by C8/CR12, CR13/CR14, and Q5. A sample of this reference appears across potentiometer R14, and presented through temperature-compensating diodes CR15/16 to the gate of programmable unijunction transistor (PUT) Q6. Also at the anode of Q6 is a sample of the output voltage. When this sample exceeds the reference sample at the gate of Q6 by more than approximately 300mV, Q6 fires, and with it, CR18. Simultaneously, CR1 on PCB A100 is fired through transformer T2, acting to shut down bias inverter A100 Q2/Q3. This has the effect of shutting off switches Q3/Q4 on the main chassis. This condition remains until the line voltage is removed.

4.2.9.2 Supply Outputs of 15 Volts and Greater

For these STM supply outputs, Q6 is a silicon unilateral switch (SUS), used as a triggering device. This device utilizes an internal voltage as the over-voltage reference. When its anode/cathode voltage exceeds this level (approximately 7.5 Vdc), it fires, abruptly reducing its voltage. As the circuit current increases, CR18 fires, shorting the output voltage. Unit shutdown occurs through the T2/A100CR1 action described in the previous paragraph.

4.2.10 Radio Frequency Interference (RFI) Control

The switching action of this type of supply might be expected to create a source of RFI. The design of the STM series has minimized this interference, using the limits specified in MIL-STD 461A as a reference.

Conducted interference on the input lines is reduced to acceptable levels by L1/L2/L3 together with C3/C4 on the main chassis. Conducted interference at the output load and sense leads is minimized by L6/L7 and C13/C14. Radiated interference is effectively minimized by the metal enclosure of the STM series power supplies.

5 SERVICE AND REPAIR

5.1 GENERAL

This section provides unit troubleshooting data, and calibration and performance-testing procedures. The troubleshooting data should be used in conjunction with the schematic diagrams (figures 5-2/5-3), location photos (figures 5-4/5-5), and previous section 4 which outlines the theory of operation. Questions pertaining to repair should be directed to the nearest Sorensen service representative or to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, N.H. 03103. Include the model and serial numbers in any correspondence. Should it be necessary to return a unit to the factory for repair, authorization from the Sorensen service dept. must first be obtained. Sorensen Company will not assume responsibility for units returned without prior authorization.

Unit troubleshooting hints are provided in tables 5-1 and 5-2 in the form of SYMPTOM/PROBABLE CAUSE/REMEDY. Where practicable, step-by-step procedures are used to facilitate isolation of a problem area.

Care should be taken when replacing any component, even if it appears obviously defective. A failed component is generally the result of a malfunction elsewhere in the system. It is the purpose of this troubleshooting procedure to help isolate both the failed component and the cause of its failure.

5.2 PERIODIC SERVICING

The STM models require no periodic servicing. However, when a unit is taken off the line it is recommended that the enclosure be inspected and cleaned of any accumulations of dust or other debris which could impede the free flow of air through the unit.

5.3 TEST EQUIPMENT REQUIRED

Use the test equipment listed (or an equivalent)

1. Oscilloscope, dual trace, 20-MHz bandwidth, isolated from ground. (Tektronix 454 with 10X voltage probe for channel A.)

2. 50-ohm, 2-watt load (in series with channel B and current probe);
- Channel B; current probe (Tektronix P6042)
3. Differential voltmeter (Fluke 845)
4. Differential voltage probe (Tektronix P6046)
5. RMS voltmeter (Hewlett Packard HP-3400A)
6. VOM (Simpson 260)

CAUTION

1. Assure that all test equipment used while troubleshooting is NOT GROUNDED. Use an isolation transformer wherever practicable.
2. Each time the unit is opened, re-check for input and output isolation to case ground before turn-on.

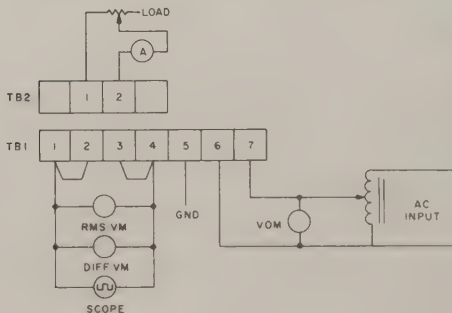


Figure 5-1
Test Equipment Setup

5.4 TROUBLESHOOTING

5.4.1 General Considerations

Before attempting repairs, the STM unit should be carefully inspected for apparent defects, such as broken or damaged components/connectors or printed circuit board, or for obvious heat damage or loose pin connections.

After replacing an electrical component, the simulated turn-on procedure outlined in paragraph 5.5.1 should be performed before placing the unit into service.

The physical size and shape of a replacement part can have an effect on the performance of the power supply. The part should therefore be a direct replacement whenever possible. Section 6 of this manual lists replaceable parts along with the Sorensen part numbers as applicable.

5.4.2 Switching Transistors Q3/Q4



The casings of these transistors are "live" during operation.

In the event power transistors Q3 and/or Q4, require replacement, the probable cause of failure should be determined before power is applied to the unit. Proceed as follows: (Use test equipment per paragraph 5-3).

1. Remove the case screws of both Q3 and Q4, isolating the collectors from the circuit.
2. With a VOM set to the R x 1 scale, measure an open circuit from Q4 emitter (-) to Transformer T1, black lead (+).
3. Check for line-to-chassis isolation. Read open circuit on VOM set to R x 10K scale.
4. With the VOM, check the drive circuit components for a possible short.

NOTE

After the cause of failure has been eliminated, proceed to simulated turn-on procedure (paragraph 5.5.1).

5.4.3 Over-Voltage Protection (OVP) Circuit

Failure in the OVP circuit can generally be traced to an improper adjustment of OVP potentiometer (R14), or one of the following:

1. For units up to 12-volts output; CR12, Q5, VR1, Q6, CR18, or an associated component, (figure 5-2).
2. For units with 15-volts (or greater) output; Q6, CR18, or an associated component, (figure 5-3).

After replacing any component in this section, the OVP should be properly set as outlined in final turn-on procedure (paragraph 5.5.2). If OVP continues to actuate, proceed to PCB A100 troubleshooting in paragraph 5.4.4.

Table 5-1 Main Chassis Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output	A. Over-voltage protection circuit tripped (fuse intact) <u>Note</u> Indication of OVP tripping is a high-pitched whistle, audible 30 seconds after unit power is removed. If whistle occurs sooner, the OVP circuit probably has not been tripped.	1) Reapply input voltage after approximately 30 seconds. 2) Verify proper setting of OVP trip point (R14, accessible through front panel). CW adjustment increases the output voltage trip point. If this adjustment resolves the problem, reset R14 per paragraph 3.3.4 in section 3 of this manual. 3) If OVP tripping recurs with normal output loading, or with no output, refer to OVP troubleshooting procedure (paragraph 5.4.3).
	B. Current limit improperly adjusted.	If, during unit calibration or repair, potentiometer R38 on PCB A100 has been left in the fully CCW position, no output will appear. Refer to final turn-on procedure (paragraph 5.5.2).
	C. Output circuit shorted (fuse not affected).	Check individual output circuit components.
	D. Input fuse open.	1) Replace fuse. 2) For repetitive fuse failures, perform the following checks as necessary. a. Remove power and replace fuse.

Table 5-1 Main Chassis Troubleshooting (cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output (cont'd)	D. Input fuse open. (cont'd)	b. Connect a VOM (Simpson 260 or equivalent) set to the R x 1 scale between the transistor case (+) and emitter (-) of Q4 (figures 5-2/5-3). A normal indication is an open circuit condition. If this occurs, continue to paragraph c. following. If a short is indicated (less than 15 ohms), remove the (Q3 and Q4) transistor case screws, which will isolate the collector(s) from the circuit. Repeat the resistance test for each transistor, collector to emitter. A short indicates a faulty transistor. Replace as necessary. <u>Note</u> After replacing Q3/Q4, do not yet insert Q3/Q4 case screws until the probable cause of failure has been determined. Refer to Q3/Q4 troubleshooting, (paragraph 5.4.2). c. Check for shorted input rectifier (CR1-CR4) as applicable). d. Check for short from input to chassis (TB1-6 or -7 to TB1-5). e. Connect the VOM across input terminals TB1-6 and -7. Remove the A100 control card. If the

Table 5-1 Main Chassis Troubleshooting (cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output (cont'd)	D. Input fuse open. (cont'd)	short is eliminated, proceed to the control PCB troubleshooting procedure (paragraph 5.4.4). f. Check for continuity: (Refer to applicable schematic diagram, figure 5-2 or 5-3) 1. Positive line output of rectifier CR1 (or CR1/CR2 cathodes as applicable) to; T1 (black lead) and R14 on A100 PCB (P1-6). 2. Negative line output of rectifier CR1 (or CR3/CR4 anodes as applicable) to; Emitter of Q4, and P1-5 on A100 PCB.
	E. Input circuit failure.	Remove case (collector) screws of transistors Q3 and Q4. Proceed to simulated turn-on procedure in paragraph 5.5.1.
2. High output	Improper setting of voltage adjust (R26) and OVP adjust (R14), accessible at front panel.	1) Reset R26 and R14 per paragraph 5.5.2 steps 6 thru 11. 2) Check for continuity from J1-1 to TB1-4, and J1-2 to TB1-1. (See tables 6-1 or 6-2 for proper resistance values.)
3. Low output	A. Current limit improperly adjusted.	Readjust per final turn-on procedure (paragraph 5.5.2).

Table 5-1 Main Chassis Troubleshooting (cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
3. Low output (cont'd)	B. VR3 on PCB A100	Refer to control PCB troubleshooting, paragraph 5.4.4.
4. Excessive ripple on output	A. Low line input	Monitor input line voltage.
	B. L5 & L6 defective.	Visually inspect for signs of deterioration or damage.
	C. C10 malfunctioning or defective	1) Check for proper tightening of C10 hold-down screws. 2) Check C10 for short/open.
5. Poor regulation	A. Measuring across load terminals	Regulation must be measured across sensing terminals.
	B. Unit overload	Load not to exceed maximum rated current specification.
	C. Current limit improperly adjusted.	Refer to adjustment procedure in paragraph 5.5.2.
	D. Control PCB A100	Check PCB per paragraph 5.4.4.

5.4.4 Control PCB A100:

Select required test equipment from the recommended list in paragraph 5.3. Assume that any equipment used is not grounded.

Refer to figure 5-6 for schematic diagram and location of components; proceed with troubleshooting as outlined in table 5-2.

CAUTION

1. Remove the switching transistor Q3/Q4 case (collector) screws before troubleshooting the control PCB.
2. After repair or replacement of circuit board, continue to simulated turn-on procedure in paragraph 5.5.1.

Table 5-2 Control Board A100 Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No unit output	Multivibrator circuit	Replace IC1, VR2, Q2 and Q3. Check for open/shorted T1 bias transformer primary (normally 12 ohms). Check capacitor C6. Check for proper trigger (45-55 usec).
2. Low unit output	Reference error amplifier	Measure approximately 16 Vdc from cathode of VR3 (+) to TP1 (-). If 16 volts appears, replace IC4. If greater than 16 volts, replace VR3. If less than 16 volts, replace IC2 and/or VR3. At NO LOAD and at minimum rated output, measure approximately 9 Vdc from TP2 (+) to TP1 (-). DO NOT APPLY LOAD WITH TEST METER CONNECTED.
3. Output drifting	Refer to probable cause and remedy of symptom 2.	
4. Poor unit regulation	Refer to probable cause and remedy of symptom 2.	
5. OVP actuates repeatedly	A. Input rectifier	Check and replace if necessary.
	B. Refer to probable cause and remedy of symptom 2.	

5.5 OPERATIONAL CHECKOUT PROCEDURES

Whenever a component is repaired or replaced, the appropriate unit turn-on procedure should be followed before placing the unit into service:

- A. Input failure (including PCB A100): perform first the simulated turn-on procedure in paragraph 5.5.1 (transistor case screws removed) and then the final turn-on procedure paragraph 5.5.2 (screws re-inserted).
- B. Output failure: perform final turn-on procedure (paragraph 5.5.2).

5.5.1 Simulated Turn-On Procedure

With the casing (collector) screws removed from transistors Q3 and Q4 proceed as follows: (Use the test equipment outlined in paragraph 5.3.)

- 1. With input power OFF, set the current limit control A100R38 fully counterclockwise (CCW).
- 2. Connect the VOM, set to the R x 100 scale, positive lead to the primary terminal (black lead) of power transformer T1, negative lead to the Q3/Q4 emitter (yellow wire). Note the capacitor charge current.
- 3. Connect the VOM, set to the R x 1 scale, to the output terminals; positive to positive and negative to negative, and note the resistance. Meter will indicate a bleeder resistance according to the unit under test. (See parts list in section 6 for resistance values.) Reverse the polarity of the VOM. Read forward biased diode in parallel with this resistance.
- 4. Connect the oscilloscope 10X probe positive lead to the base of the upper switching transistor (Q4), with the negative lead at the emitter. Set the oscilloscope sensitivity to 0.2V/division, timing to 20 usec/division and on the dc scale.

5. Clip the current probe to the common emitter lead of the switching transistors with the current direction (arrow) leaving the transistors into the main PCB. Set the oscilloscope sensitivity to .5A/division.
6. Momentarily apply, then quickly remove input power. Observe oscilloscope, and adjust as necessary for indication of a clean, square waveform on channel A. Repeat as necessary.

NOTE

Inability to obtain the waveform indicates a malfunction in the control PCB (refer to paragraph 5.4.4).

7. Place line power to ON. The unit should be working under deep current limiting mode. Check the following: (See waveform pattern "A", figure 5-7.)
 - (a) The oscillating square wave repetition should be from 45 to 55 microseconds.
 - (b) The peak level of the square waveform is at 0 volt, and the lower level is from (-)4 to (-)6.5 volts.
 - (c) No current will be detected by the current probe on channel B; only some very thin switching spikes of no significant magnitude should be evident.
8. Slowly adjust A100R38 CW. On the oscilloscope, the presence of a duty cycle will be observed. (See waveform patterns "B" and "C", figure 5-7.) If A100R38 has no control over the duty cycle, check CR11/CR15 or C15.
9. Check that the current waveform in pattern "C" has twice the repetition rate of the voltage waveform "B", and also note that current pulses are reasonably similar in amplitude. If both of these events are not as stated, check the transistor drive circuit components.

NOTE

The procedure to this point verifies the proper functioning of the input drive and power transistor circuits. Continue only when the conditions of steps 7, 8 and 9 have been satisfied.

10. Re-insert Q3/Q4 (collector) screws. Connect a VOM, set to the R x 10K scale, from Q3/Q4 case to chassis. Read open circuit.

5.5.2 Final Turn-On Procedure

If the switching transistors and/or drive circuit components have been changed, perform tests per paragraph 5.5.1 before continuing.

1. Remove input power and connect test equipment as in steps 4. and 5. of previous paragraph 5.5.1.
2. Connect the dc differential voltmeter and rms voltmeter across the output sensing terminals (TB1-1 and -4).
3. On front panel, set the output voltage control (R26) to its approximate mid-range, and the OVP control R14 fully CW.
4. Remove load from output.
5. Set current limit adjust (A100) R38 fully CCW.
6. Apply nominal input power and turn A100R38 slowly CW. The output voltage should increase and the current waveform on oscilloscope channel B should appear as in pattern "D" of figure 5-7.

NOTE

At this point, three phenomena should be carefully watched:

- (a) If there is a short in the power transformer (T1) primary winding, the current waveform will have alternate duty cycle pulses missing when the unit is out of current limiting.
 - (b) If there is a short at the secondary winding or at the output, the current will appear excessive. Normally, when the output is at no load the current observed on the oscilloscope should be no greater than 1.5 amperes.
 - (c) If the unit oscillates with audible noise, attempt to tighten up the hold-down screws on output capacitor C10.
- 7. Apply full rated load current. Adjust balance control A100R50 to equalize as close as possible the main conducting portion of any two adjacent emitter current waveforms as indicated in pattern "D" of figure 5-7.
 - 8. Set current limit control A100R38 at 115% of rated full-load current (per table 1-1B/C).
 - 9. Remove output load current. Set output voltage control R26 to 110% of rated output voltage (per table 1-1B/C).
 - 10. Slowly turn OVP control R14 CCW until it shuts the unit off.
 - 11. Turn R26 at least one full turn CCW, and remove input voltage. After 1 minute, re-apply input, and adjust R26 for rated output.

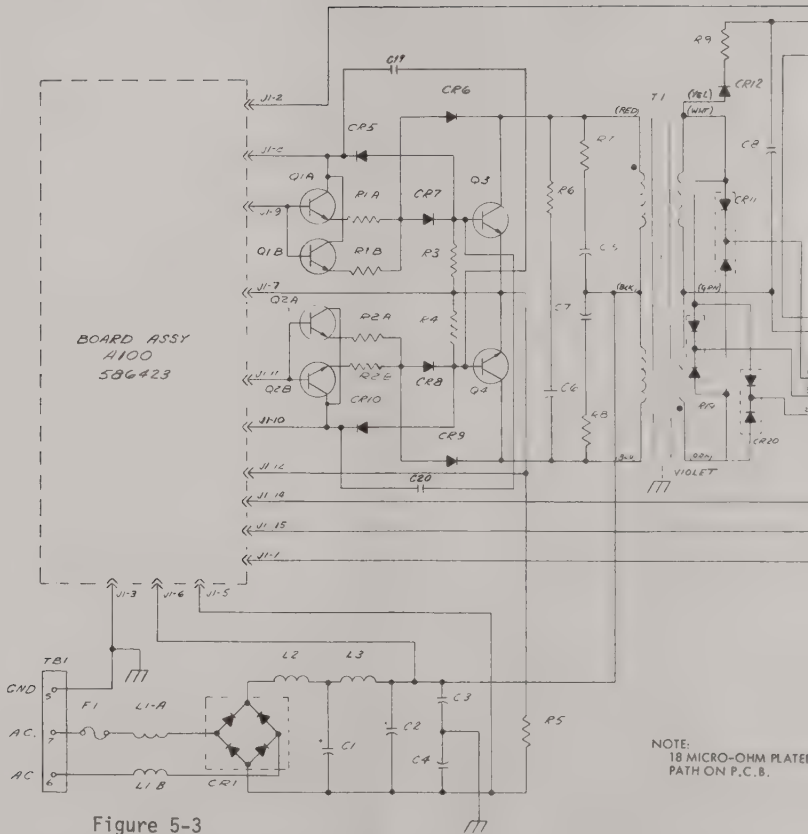
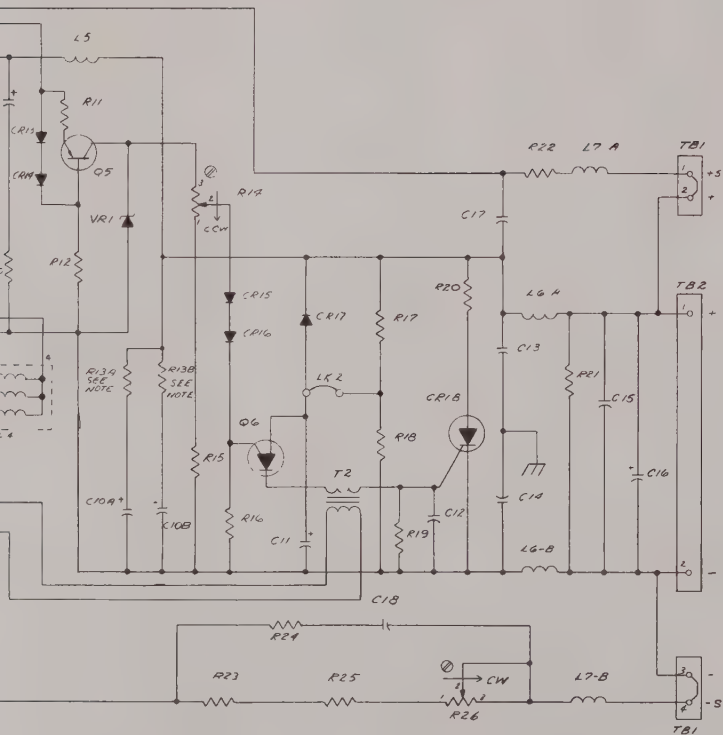
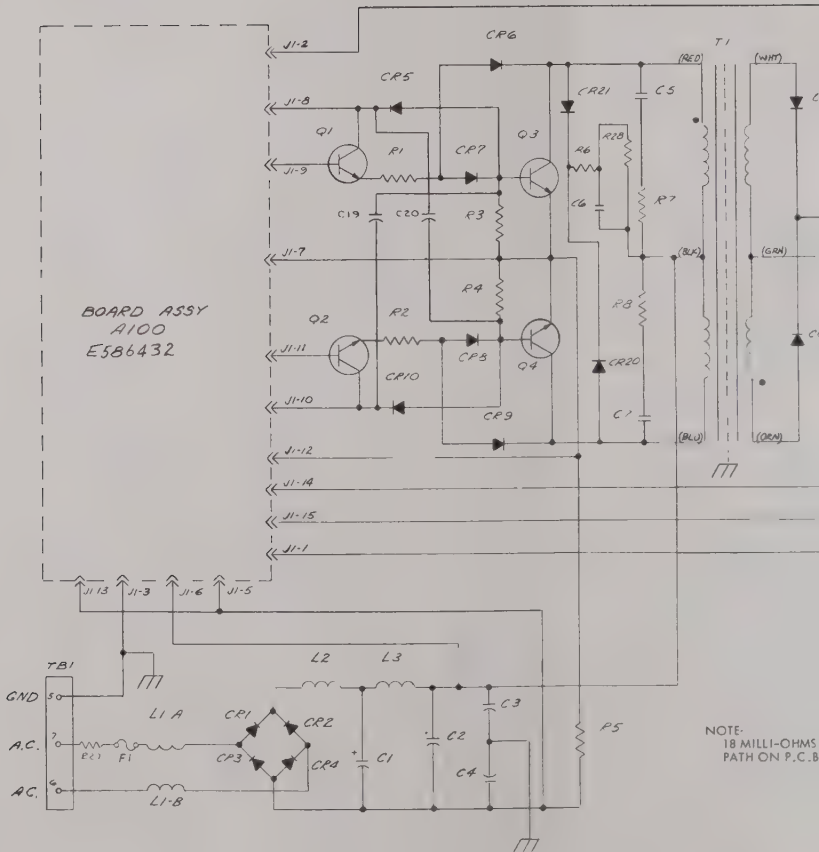


Figure 5-3
STM 15-48 Volt Units
Typical Schematic Diagram





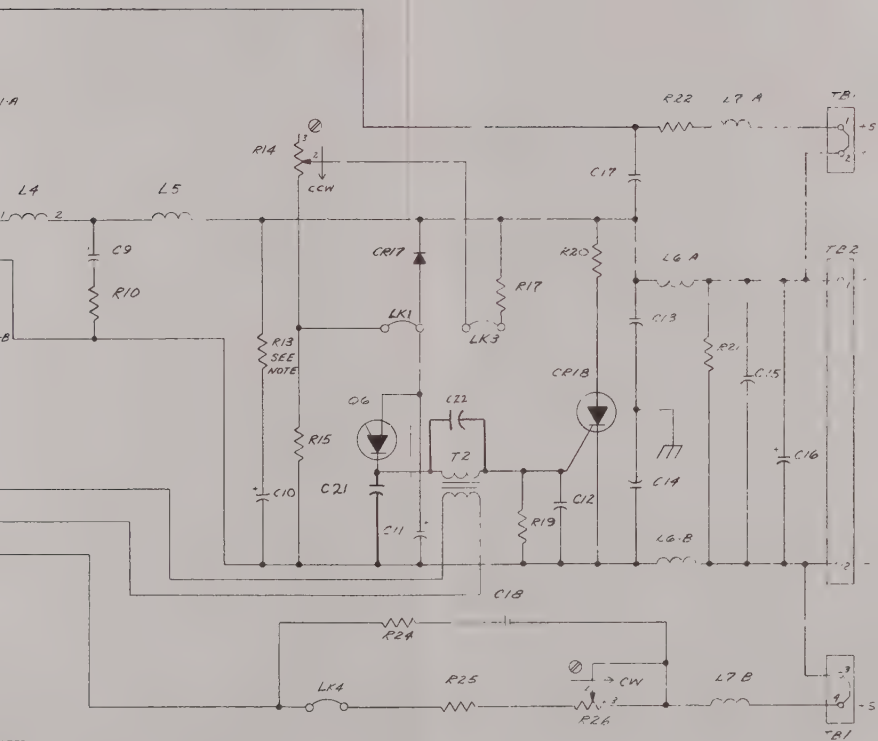


Figure 5-2
STM 3-12 Volt Units
Typical Schematic Diagram

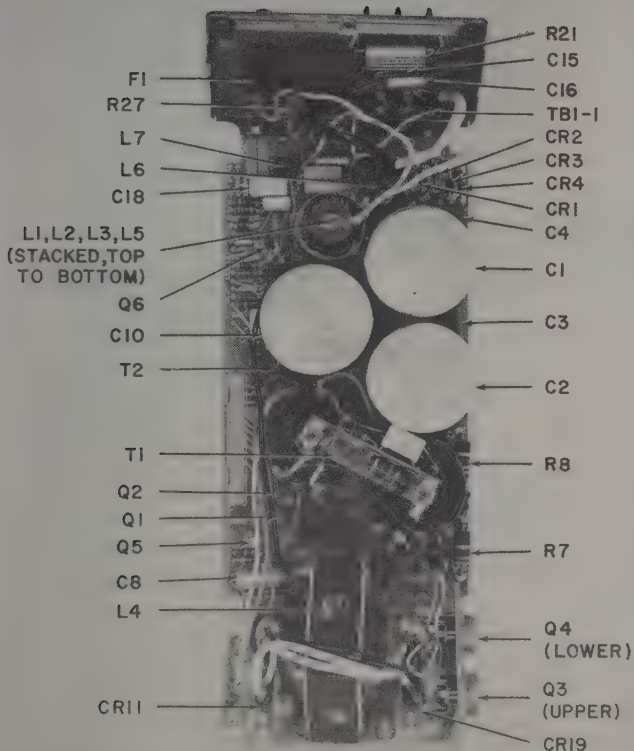
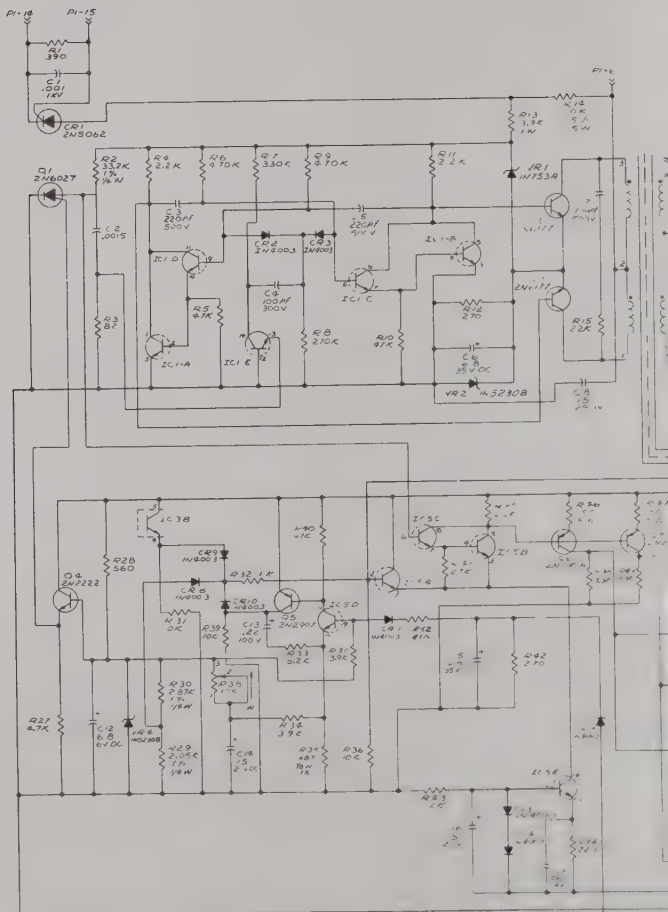


Figure 5-4
 Module III-Typical Component
 Location Photo



E586432 REV D

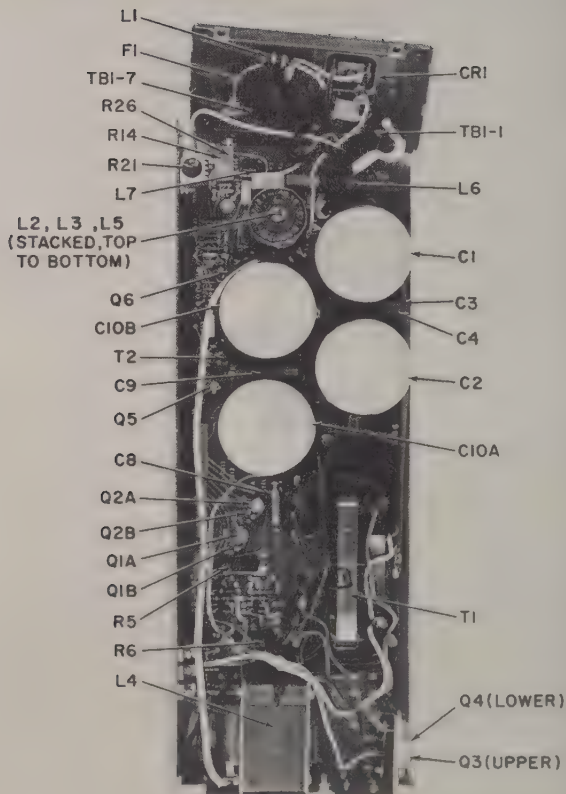
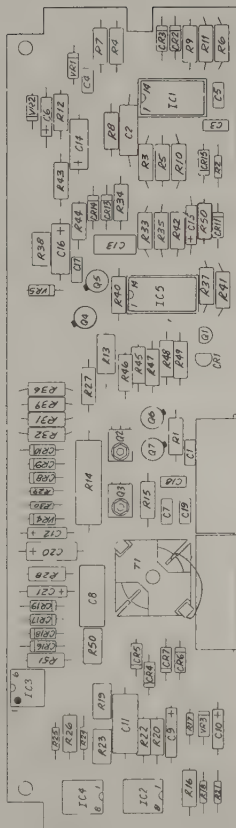


Figure 5-5
Module IIIA-Typical Component
Location Photo



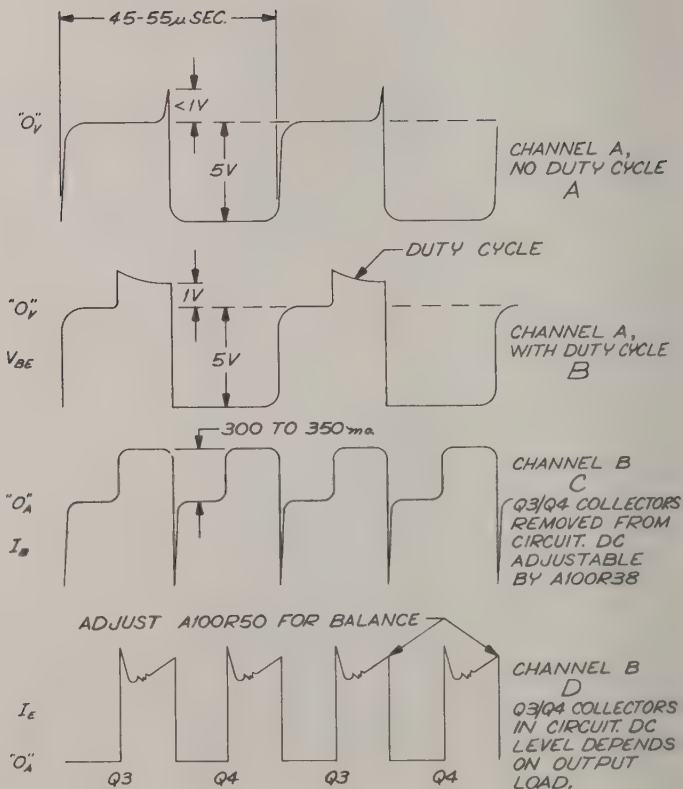


Figure 5-7
Switching Transistor Waveforms

6 REPLACEABLE PARTS LISTS

6.1 INTRODUCTION

This section provides a coded replaceable parts list, keyed to the schematic diagram and parts location diagrams appearing in section 5. All module III models are covered by table 6-1; all Module IIIA models are covered by table 6-2.

6.2 APPLICATION, MODULE III

Table 6-1 lists the replaceable parts for the following models:

<u>Model</u>	<u>U/O Code</u>	<u>Model</u>	<u>U/O Code</u>
3.5-24	1	18-10	6
5-24	2	24-8.5	7
9-12	3	28-7	8
12-12	4	36-4	9
15-10	5	48-4	10

6.3 TABLE HEADINGS DEFINED

6.3.1 Used-On Code (U/O)

This number (see above) will identify those models using the part in the particular table. If a part is common to several models, the used-on code will show this (for example, 1-3 indicates codes 1, 2 and 3).

6.3.2 Reference Designation (REF DES)

This number will identify the component as called out on the schematic diagram.

6.3.3 Sorensen Part No.

This number should be used when ordering parts direct from Sorensen Company, Manchester, N.H.

Table 6-1 Replaceable Parts List-STM Module III

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Capacitors</u> (uF unless stated)			
C1	1000, 200V	586052-1	1-10
C2	1000, 200V	586052-1	1-10
C3	.02, 1KV	24-2029	1-10
C4	.02, 1KV	24-2029	1-10
C5	560pF, 500V	235-7053P317	1-10
C6	1, 250V	24-2015-13	1-10
C7	560pF, 500V	235-7053P317	1-10
C8	100, 25V	24-2279-14	1-4
C9	120, 10V	586057-8	1, 2
	47, 20V	586385-8	3, 4
	22, 35V	586058-23	5-7
	18, 50V	585071-44	8
	3.9, 75V	586386-5	9, 10
	19500, 25V	586043-2	1-3, 6-8
C10	4600, 75V	586051-1	4, 5, 9, 10
	4.7, 10V	586057-2	1-10
C11	.022, 250V	24-2015-5	1-10
C12	.01, 250V	24-2015-1	1-10
C13	.01, 250V	24-2015-1	1-10
C14	.1, 100V	24-2037-7	1-4
C15	.22, 100V	24-2037-11	5-10
	10, 75V	586386-8	1-4, 9, 10
	22, 35V	586058-23	5, 6, 7
	18, 50V	585071-44	8
C16	.22, 100V	24-2037-11	1-10
C17	1, 100V	24-2037-19	1-10
C18	.003, 600V	235-7207P51	1-10
C19	.003, 600V	235-7207P51	1-10
C20	.003, 600V	235-7207P51	1-10
<u>Diodes</u>			
CR1	1N5403	26-1160-4	1-10
CR2	1N5403	26-1160-4	1-10
CR3	1N5403	26-1160-4	1-10
CR4	1N5403	26-1160-4	1-10

Table 6-1 Replaceable Parts List-STM Module III (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Diodes</u> (cont'd)			
CR5	388A	586379-1	1-10
CR6	388H	586379-6	1-10
CR7	388A	586379-1	1-10
CR8	388A	586379-1	1-10
CR9	388H	586379-6	1-10
CR10	388A	586379-1	1-10
CR11	Rectifier 200V	586462-3	1, 2
	200V	586462-3	3-8
CR11 (A&B)	300V	586462-4	9, 10
CR12	1N4003	322-7236P3	1-4
CR13	1N4003	322-7236P3	1-4
CR14	1N4003	322-7236P3	1-4
CR15	1N4003	322-7236P3	1-4
CR16	1N4003	322-7236P3	1-4
CR17	1N4003	322-7236P3	1-10
CR18	C106Y21	26-1052	1-6
	C106F21	26-1066	7, 8
	C106A21	26-1105	9, 10
CR19	Rectifier 200V	586462-3	1, 2
CR20	388H	586379-6	1-10
CR21	388H	586379-6	1-10
<u>Fuses</u>			
F1	6A, 250V	42-415	1-10
<u>Inductors</u>			
L1	Coil, Toroid-STM	586416-1	1-10
L2	Coil, Toroid-STM	586410-1	1-10
L3	Coil, Toroid-STM	586410-1	1-10
L4	Choke Assy.	586308-1	1, 2

Table 6-1 Replaceable Parts List-STM Module III (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Inductors (cont'd)</u>			
L4 (cont'd)	Choke Assy.	586302-2	3, 4
		586308-3	5, 6
		586308-4	7, 8
		586308-5	9, 10
L5	Choke Assy.	586396-1	1, 2
		586396-2	3, 4
		586396-3	5, 6
		586396-4	7, 8
L6	Choke	586396-5	9, 10
		586523-1	1, 2
		586524-1	3, 4
		586525-1	5, 6
L7	Choke	586526-1	7, 8
		586527-1	9, 10
		586471-1	1-10
		<u>Transistors</u>	
Q1	2N3019	386-7316P1	1-10
Q2	2N3019	386-7316P1	1-10
Q3	40853, NPN	586520-4	1-10
Q4	40853, NPN	586520-4	1-10
Q5	2N2907A	386-7249P58	1-4
Q6	2N6027	386-7304P1	1-4
	2N4990	586063-2	5-10
<u>Resistors (ohms, $\pm 10\%$ unless stated)</u>			
R1	10, 1W	280-1146P2	1, 2
	10, 1/2W	27-180	3-10
R2	10, 1W	280-1146P2	1, 2
	10, 1/2W	27-180	3-10
R3	180, 1/2W	280-1145P47	1-10
R4	180, 1/2W	280-1145P47	1-10

Table 6-1 Replaceable Parts List-STM Module III (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Resistors</u> (ohms, $\pm 10\%$ unless otherwise stated)-(cont'd)			
R5	.39, 5W, 5%	586054-8	1, 2
	.33, 5W, 5%	586054-7	3, 4
	.27, 7W	27-140-11	5-10
R6	22, 1/2W	27-153	1-10
R7	330, 2W	27-361	1-10
R8	330, 2W	27-361	1-10
R9	10, 1/2W	27-180	1-4
R10	.18, 3W	27-397-7	1, 2
	.56, 3W	27-397-19	3-5
	1.2, 3W, 5%	27-397-27	6-8
	6.8, 3W, 5%	27-397-45	9, 10
R11	82, 1/2W	28-2000	1-4
R12	2700, 1/2W	28-2109	1, 2
	5600, 1/2W	28-2003	3, 4
R13	Not Used		
R14	Variable 2K	586371-5	1-8
	Variable 5K	586371-6	9, 10
R15	1300, 1/4W, 1%	28-1333	1-4
	681, 1/4W, 1%	586250-66	5, 6, 9, 10
	422, 1/4W, 1%	586250-56	7, 8
R16	3300, 1/2W	27-140	1-4
R17	1300, 1/4W, 1%	28-1333	1, 2, 9, 10
	7150, 1/4W, 1%	586250-115	3, 4
	280-1/4W, 1%	28-1284	5, 6
	422, 1/4W, 1%	586250-56	7, 8
R18	3320, 1/4W, 1%	586250-99	1-4
R19	33, 1/2W	27-178	1-10
R20	.56, 3W	27-397-19	1, 2
	1.2, 3W, 5%	27-397-27	3, 4
	1.8, 3W, 5%	27-397-31	5, 6
	2.7, 3W, 5%	27-397-35	7, 8
	4.7, 3W, 5%	27-397-41	9, 10
R21	2.8, 25W, 3%	586369-506	1
	4.53, 25W, 3%	586369-511	2

Table 6-1 Replaceable Parts List-STM Module III (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Resistors</u> (ohms, $\pm 10\%$ unless otherwise stated)-(cont'd)			
R21 (cont'd)	8.66, 25W, 1%	586369-187	3
	15, 25W, 3%	586369-518	4
	24.9, 25W, 3%	586369-522	5
	34.8, 25W, 3%	586369-526	6
	45.3, 25W, 3%	586369-529	7
	75, 25W, 3%	586369-532	8
	137, 25W, 1%	586369-302	9
	221, 25W, 3%	586369-538	10
R22	100, 1/2W	27-173	1-10
R23	1500, 1/8W, 1%	586055-185	2
	3480, 1/8W, 1%	586055-100	4
	2940, 1/8W, 1%	586055-186	6
	4990, 1/8W, 1%	586055-187	8
	13K, 1/8W, 1%	586055-189	10
R24	680, 1/2W, 1%	27-156	1-10
R25	2940, 1/8W, 1%	586055-186	1, 2
	5900, 1/8W, 1%	586055-111	3, 4
	12.7K, 1/8W, 1%	586055-127	5, 6
	18.7K, 1/8W, 1%	586055-135	7, 8
	28.7K, 1/8W, 1%	586055-144	9, 10
R26	Variable 2K	586371-5	1, 2
	Variable 5K	586371-6	3-6
	Variable 10K	586371-7	7, 8
	Variable 20K	586371-8	9, 10
R27	.18, 12.5W, 5%	27-590-7	1-10
<u>Transformers</u>			
T1	Power	586280-1	1, 2
	Power	586275-1	3, 4
	Power	586292-1	5, 6
	Power	586292-4	7
	Power	586292-2	8
	Power	586292-3	9, 10
T2	Pulse	586340-1	1-10
VR1	Diode, Zener		
	1N825	26-205	1-4

6.4 APPLICATION, MODULE IIIA

Table 6-2 lists the replaceable parts for the following STM models:

<u>Model</u>	<u>U/O Code</u>	<u>Model</u>	<u>U/O Code</u>
3.5-36	1	18-15	6
5-36	2	24-13	7
9-20	3	28-11	8
12-20	4	36-6	9
15-15	5	48-6	10

Refer to paragraph 6-3 for definitions of table headings: U/O CODE, REF DES and SORESEN P/N.

Table 6-2 Replaceable Parts List-STM Module IIIA

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Capacitors</u> (uF unless stated)			
C1	1000, 200V	586052-1	1-10
C2	1000, 200V	586052-1	1-10
C3	.02, 1KV	24-2029	1-10
C4	.02, 1KV	24-2029	1-10
C5	.001, 1KV	235-7421P14	1-10
C6	.001, 1KV	235-7421P14	3-10
	680PF	235-7421P10	1, 2
C7	.001, 1KV	235-7421P14	1-10
C8	100, 25V	24-2279-14	1-4
C9	220, 10V	586057-10	1, 2
	100, 20V	586385-10	3, 4
	47, 35V	586058-27	5-7
	18, 50V	585071-44	8
	10, 75V	586386-8	9, 10
C10 (A&B)	19500, 25V	586043-2	1-6
	4600, 75V	586051-1	7-10
C11	4.7, 10V	586057-2	1-10
C12	.022, 250V	24-2015-5	1-10
C13	.01, 250V	24-2015-1	1-10
C14	.01, 250V	24-2015-1	1-10
C15	.1, 100V	24-2037-7	1-6
	.22, 100V	24-2037-11	7, 9
C16	120, 10V	586057-8	1, 2
	47, 20V	586385-8	3, 4
	22, 35V	586058-23	5-7
	18, 50V	585071-44	8
	10, 75V	586386-8	9, 10
C17	.22, 100V	24-2037-11	1-10
C18	1, 100V	24-2037-19	1-10
C19	.003, 600V	235-7207P51	1-10
C20	.003, 600V	235-7207P51	1-10
C21	.47, 35V	586058-3	5-10
C22	.003	235-7207P51	5-10

Table 6-2 Replaceable Parts List-STM Module IIIA (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Diodes</u>			
CR1	Rectifier	586050-2	1-10
CR2	Not Used		
CR3	Not Used		
CR4	Not Used		
CR5	388A	586379-1	1-10
CR6	388H	586379-6	1-10
CR7	388A	586379-1	1-10
CR8	388A	586379-1	1-10
CR9	388H	586379-6	1-10
CR10	388A	586379-1	1-10
CR11	Rectifier 200V	586462-3	1-8
CR11 (A&B)	300V	586378-4	9, 10
CR12	1N4003	322-7236P3	1-4
CR13	1N4003	322-7236P3	1-4
CR14	1N4003	322-7236P3	1-4
CR15	1N4003	322-7236P3	1-4
CR16	1N4003	322-7236P3	1-4
CR17	1N4003	322-7236P3	1-10
CR18	C106Y21	26-1052	1-6
	C106F21	26-1066	7, 8
	C106A21	26-1105	9, 10
CR19	Rectifier 200V	586462-3	1-4
CR20	Rectifier 200V	586462-3	1, 2
<u>Fuses</u>			
F1	8A, 115V	42-428	1-10
<u>Inductors</u>			
L1	Coil, Toroid	586676-1	1-10
L2	Choke Assy.	586548-1	1, 2
		586548-2	3, 4
		586548-3	5-7
		586548-4	8
		586548-5	9, 10

Table 6-2 Replaceable Parts List-STM Module IIIA (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Inductors</u> (cont'd)			
L3	Choke Assy.	586548-1	1, 2
		586548-2	3, 4
		586548-3	5-7
		586548-4	8
		586548-5	9, 10
L4	Choke Assy.	586538-1	1, 2
		586538-2	3, 4
		586538-3	5, 6
		586538-4	7
		586538-5	8
L5	Choke Assy.	586538-6	9, 10
		586548-1	1, 2
		586548-2	3, 4
		586548-3	5-7
		586548-4	8
L6	Choke	586548-5	9, 10
		586523-1	1, 2
		586524-1	3, 4
		586525-1	5, 6
		586526-1	7, 8
L7	Choke	586527-1	9, 10
		586471-1	1-10
<u>Transistors</u>			
Q1 (A&B)	2N3019	386-7316P1	1-10
Q2 (A&B)	2N3019	386-7316P1	1-10
Q3	40854, NPN	586520-5	1-10
Q4	40854, NPN	586520-5	1-10
Q5	2N2907A	386-7249P58	1-4
Q6	2N6027	386-7304P1	1-4
	2N4990	586063-2	5-10

Table 6-2 Replaceable Parts List-STM Module IIAA (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
Resistors (ohms, $\pm 10\%$ unless stated)			
R1 (A&B)	12, 1W	280-1146P5	1-10
R2 (A&B)	12, 1W	280-1146P5	1-10
R3	68, 1/2W	27-160	1-10
R4	68, 1/2W	27-160	1-10
R5	.05, 5W, 5%	586054-5	3-4
	.18, 7W	27-470-7	5-10
	.27, 5W, 5%	586054-6	1-2
R6	680, 5W, 5%	586054-47	1-10
R7	220, 5W, 5%	586054-41	1-10
R8	220, 5W, 5%	586054-41	1-10
R9	10, 1/2W	27-180	1-4
R10	.10, 3W	27-397-1	1, 2
	.22, 3W	27-397-9	3, 4
	.56, 3W	27-397-19	5-8
	3.3, 3W, 5%	27-397-37	9, 10
R11	82, 1/2W	28-2000	1-4
R12	2700, 1/2W	28-2109	1, 2
	5600, 1/2W	28-2003	3, 4
R13	Not Used		
R14	Variable 2K	586371-5	1-10
R15	1300, 1/4W, 1%	28-1333	1-4
	681, 1/4W, 1%	586250-66	5, 6, 9, 10
	422, 1/4W, 1%	586250-56	7, 8
R16	3300, 1/2W	27-140	1-4
R17	1300, 1/4W, 1%	28-1333	1, 2, 9, 10
	7150, 1/4W, 1%	586250-115	3, 4
	280, 1/4W, 1%	28-1284	5, 6
	422, 1/4W, 1%	586250-56	7, 8
R18	3.3K, 1/4W, 1%	28-1326	1-4
R19	33, 1/2W	27-178	1-10
R20	.56, 3W	27-397-19	1, 2
	1.2, 3W, 5%	27-397-27	3, 4
	1.8, 3W, 5%	27-397-31	5, 6
	2.7, 3W, 5%	27-397-35	7, 8
	4.7, 3W, 5%	27-397-41	9, 10

Table 6-2 Replaceable Parts List-STM Module IIIA (cont'd)

REF DES	DESCRIPTION	SORENSEN P/N	U/O CODE
<u>Resistors</u> (ohms, $\pm 10\%$ unless stated) - (cont'd)			
R21	1.82, 50W, 3%	586677-502	1
	2.80, 50W, 3%	586677-506	2
	6.04, 50W, 3%	586677-514	3
	10, 50W, 3%	586677-516	4
	18.2, 50W, 3%	586677-519	5
	20, 50W, 3%	586677-520	6
	34.8, 50W, 3%	586677-526	7
	45.3, 50W, 3%	586677-529	8
	86.6, 50W, 3%	586677-568	9
	121, 50W, 3%	586677-534	10
R22	100, 1/2W	27-173	1-10
R23	1500, 1/8W, 1%	586055-185	2
	3480, 1/8W, 1%	586055-100	4
	2940, 1/8W, 1%	586055-186	6
	4990, 1/8W, 1%	586055-187	8
	13K, 1/8W, 1%	586055-189	10
R24	680, 1/2W, 1%	27-156	1-6, 8-10
	1K, 1%	27-103	7
R25	2940, 1/8W, 1%	586055-186	1, 2
	5900, 1/8W, 1%	586055-111	3, 4
	12.7K, 1/8W, 1%	586055-127	5, 6
	18.7K, 1/8W, 1%	586055-135	7, 8
	28.7K, 1/8W, 1%	586055-144	9, 10
R26	Variable 2K	586371-5	1, 2
	Variable 5K	586371-6	3-6
	Variable 10K	586371-7	7, 8
	Variable 20K	586371-8	9, 10
<u>Transformers</u>			
T1	Power	586513-1	1, 2
		586513-2	3, 4
		586515-1	5, 6
		586515-2	7
		586515-3	8
		586516-1	9, 10
VR1	Diode, Zener 1N825	26-205	1-4

6.5 APPLICATION, CONTROL PCB A100

Table 6-3 summarizes the replaceable parts for the STM control printed circuit board. This board is compatible with all models of the STM series contained in module groups III and IIIA.

Table headings are outlined in paragraph 6.3 on page 6-1. Figure 5-6 is the assembly drawing of the A100 PCB, physically locating each component.

Table 6-3 Replaceable Parts List-A100 PCB
Assembly 586423-1

REF DES	DESCRIPTION	SORENSEN P/N
<u>Capacitors:</u> (uF, $\pm 10\%$ unless otherwise noted)		
C1	0.001, 1KV	235-7421P14
C2	0.0015, 200V	24-2409-2
C3	220pF, 500V	235-7053P286
C4	100pF, 300V	235-7053P89
C5	220pF, 500V	235-7053P286
C6	6.8, 35V	586058-17
C7	100pF, 500V	235-7053P254
C8	0.15, 250V	24-2015-15
C9	6.8, 35V	586058-17
C10	4.7, 10V	586057-2
C11	0.01, 200V	24-2409-7
C12	6.8, 6V	586384-2
C13	0.22, 100V	24-2037-11
C14	15, 20V	586385-5
C15	6.8, 35V	586058-17
C16	15, 20V	586385-5
C17	0.001, 1KV	235-7421P14
C18	0.001, 1KV	235-7421P14
C19	0.001, 1KV	235-7421P14
C20	15, 20V	586385-5
C21	2.2, 20V	586385-2
C22	0.015, 250V	24-2015-3
C23	0.0022, 200V	24-2409-3
C24	0.015, 250V	24-2015-3
C25	0.0022, 200V	24-2409-3
<u>Rectifiers:</u> (Diodes)		
CR1	2N5062, 100V, SCR	322-7243P3
CR2-11/13-19	1N4003, 200V, 1A	322-7236P3
CR12	Not Used	
<u>Integrated Circuits:</u>		
IC1	CA3086	386-7319P3
IC2	LM741C	586372-1
IC3	Photo Xstr	586463-1
IC4	LM741C	586372-1
IC5	CA3086	386-7319P3

Table 6-3 Replaceable Parts List-A100 PCB
(cont'd)

REF DES	DESCRIPTION	SORENSEN P/N
<u>Transistors:</u>		
Q1	2N6027	386-7304P1
Q2	2N6177	586519-3
Q3	2N6177	586519-3
Q4	2N2222A	386-7249P57
Q5	2N2907A	386-7249P58
Q6	2N2907A	386-7249P58
Q7	2N2907A	386-7249P58
Q8	2N2907	386-7249P54
<u>Resistors:</u> (ohms, 1/2W, $\pm 10\%$ unless otherwise noted)		
R1	390	27-1109
R2	33.2K, 1/4W, 1%	586250-147
R3	82	27-1115
R4	2.2K	27-152
R5	47K	27-112
R6	470K	27-146
R7	330K	27-148
R8	270K	27-121
R9	470K	27-146
R10	47K	27-112
R11	2.2K	27-152
R12	270	27-191
R13	3.9K, 1W	280-1180P95
R14	10K, 5W, 5%	586054-61
R15	22K, 1W	280-1180P122
R16	1K	27-103
R17	10K, 1/4W, 1%	586250-122
R18	15.4K, 1/4W, 1%	586250-131
R19	Variable, 10K	586370-7
R20	470	27-166
R21	1.3K, 1/4W, 1%	28-1333
R22	22K	27-142
R23	Variable, 10K	586370-7
R24	53.6K, 1/4W, 1%	586250-157
R25	6.65K, 1/8W, 1%	586055-188
R26	2.2K	27-152
R27	4.7K	27-107
R28	560	27-1103
R29	2.05K, 1/4W, 1%	586250-89

Table 6-3 Replaceable Parts List-A100 PCB
(cont'd)

REF DES	DESCRIPTION	SORENSEN P/N
<u>Resistors:</u> (ohms, 1/2W, $\pm 10\%$ unless otherwise noted)-(cont'd)		
R30	2.87K, 1/4W, 1%	586250-96
R31	10K	27-133
R32	1K	27-103
R33	8.2K	280-1145P107
R34	3.9K	280-1145P95
R35	487, 1/8W, 1%	586250-59
R36	10K	27-133
R37	3.9K	280-1145P95
R38	Variable, 10K	586370-7
R39	10K	27-133
R40	47K	27-112
R41	27K	27-110
R42	270	27-191
R43	1.2K	27-1110
R44	220	27-101
R45	2.2K	27-152
R46	150	27-1113
R47	150	27-1113
R48	3.3K	27-140
R49	3.3K	27-140
R50	Variable, 10K	586370-7
R51	100	280-1145P146
R52	47	27-112
R53	270K	27-121
R54	10K	280-1145P110
T1	Transformer	586338-1
<u>Zener Voltage Regulators:</u>		
VR1	1N753A, 6.2V	26-104
VR2	1N750A, 4.7V	26-211
VR3	1N825, 6.2V	26-205
VR4	1N750A, 4.7V	26-211
VR5	1N753A, 6.2V	26-104